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Fracture and Tensile Strength of Oxide Glass fibers

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Understanding of the fracture mechanism and tensile strength of glass and glass fibers has been a challenging subject for glass scientists over the past century. In the present work, we report our recent findngs about the sources of the higher strength of the oxide glass fibers compared to the bull glass with same chemical composition. The objects of this study are both continuous glass fibers and discontinuous wool fibers, which are spun from both the E-glass and the basaltic glass melts, respectively. The diameter dependence of the tensile strength of glass fibers is discussed in terms of structural anisotropy, enthalpy relaxation, defect orientation, and surface characteristics. Based on a large amount of the tensile strength data, it is inferred that the fiber drawing stress plays a crucial role in enhancing the strength of the oxide glass fibers. This strength enhancement could be attributed to the two factors: the structural anisotropy and the macroscopic defect (flaws, bubbles, striae et al) orientation, both of which are induced by the fiber drawing stress. This finding is further verified by annealing experiments on both continuous and wool fibers below T_g. The onset annealing temperature of the tensile strength decay is close to that of the anisotropy relaxation of the continuous fibers. The relative contributions of the different factors to the fiber strength are quantitatively distinguished and estimated in terms of the tensile strength decay as a function of the sub-T_g annealing temperature, and this contributes to understanding of the fracture mechanism of glass fibers.